Lean Product Development

Real results from Lean Product Development & Teamcenter

June 2008

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Audit.Tax.Consulting.Financial Advisory.

Topics of Discussion

Introduction and overview

- What is lean product development
- Common lean approaches
- Looking beyond common approaches
- How and when to best apply Teamcenter tools to a lean process
- Case studies

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Introductions

Brian Meeker
Senior Manager

Brian is a Senior Manager and leads our product development practice for the East Coast/Midwest and has 12 years of consulting experience working with automotive, industrial products, high-tech and consumer product companies. He has led a number of lean product development and engineering effectiveness projects for a variety of clients. His other relevant experiences include the redesign and implementation of new product development processes and PDM tools (UGS – Teamcenter and Agile). Brian holds an MBA from Case Western Reserve University and a BS from Miami of Ohio. He has also been certified as a Black Belt by Deloitte's Enterprise Lean-Six Sigma practice. Brian is currently leading a Lean Engineering Transformation using TCe 2007 and TcSE at a heavy equipment manufacturer.

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Deloitte's Product Development Services

Deloitte Consulting offers 360º services to address our clients' strategic and operational challenges in product development.

Key Issues Addressed:

- How do I balance core and contingent R&D strategies to achieve a flexible growth strategy?
- How do I get the most out of my current product and technology portfolio?
- How do I reduce product line complexity while increasing customer satisfaction and profit margins?
- How do I get the most out of my engineering and product development resources?
- How do I quickly and cost effectively ramp production of new products and manage change throughout a product's lifecycle?
- How do I efficiently manage complex, collaborative product development programs?
- How do I enable "virtual" product development – potentially across company lines?
- How do I link the sales and customer service functions to product development?
- How do I effectively integrate regulatory compliance into the overall product innovation strategy?
- How do I enable the product development and lifecycle management processes with technology?
- How do I leverage and share all of my product data throughout the development effort?
- How do I efficiently and effectively manage product changes?
- How do I manage the stage-gate/spiral product development process?

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Translation of Lean Principles to Product Development

There are strong parallels between manufacturing lean and lean applied to product development

Lean Concepts	Common Issues	Manufacturing Solutions	Engineering / NPI Solutions
Customer Focus	▪ Over investment in low-value areas ▪ Lack of customer collaboration	▪ VOC ▪ Demand-driven manufacturing	▪ VOC ▪ QFD ▪ Requirements prioritization
Demand Smoothing	▪ Erratic work spikes ▪ Expediting and overtime	▪ Demand forecasting / shaping ▪ Capacity planning ▪ Time-fencing	▪ Product & technology roadmaps ▪ Portfolio planning ▪ Resource planning
Pull / Flow	▪ High WIP levels ▪ Reduced velocity ▪ Lack of priorities ▪ Expediting ▪ Excessive hand-offs	▪ Single piece flow ▪ Replenishment signals ▪ Bottleneck management and material flow optimization ▪ Work linkage & synchronization ▪ Cellular manufacturing ▪ Takt and throughput analysis	▪ Single project flow ▪ Critical path analysis ▪ Task linkage and synchronization ▪ Integrated cross functional product teams ▪ Throughput / velocity improvement
Standard Work / Work Balancing	▪ Inconsistent work practices ▪ Work "starving" or "queuing"	▪ Standard work instructions ▪ Works standards ▪ Line / takt balancing	▪ Standard deliverable templates ▪ Reuse of designs and specifications ▪ Resource load planning
First-Pass Success	▪ Rework ▪ Non-conformance ▪ Lack of process capability	▪ Error proofing ▪ Process capability analysis ▪ Process control ▪ Root cause and corrective action	▪ Error proofing ▪ Root cause analysis ▪ Engineering churn metrics

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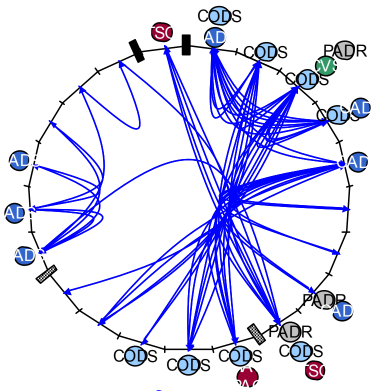
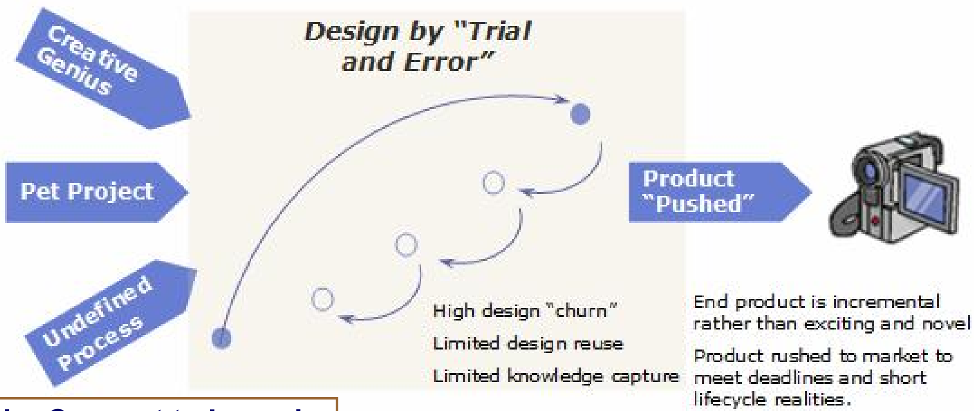
Lean Product Development in Action

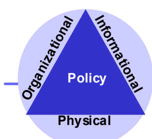
Lack of Knowledge Promotes Average Results



Actual workflow is analyzed via work visualization tools

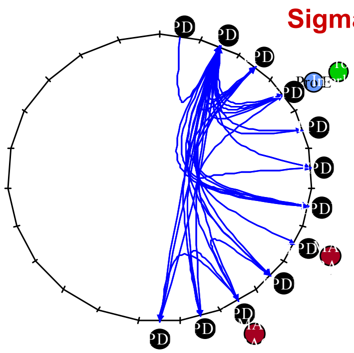


18 month : Concept to Launch

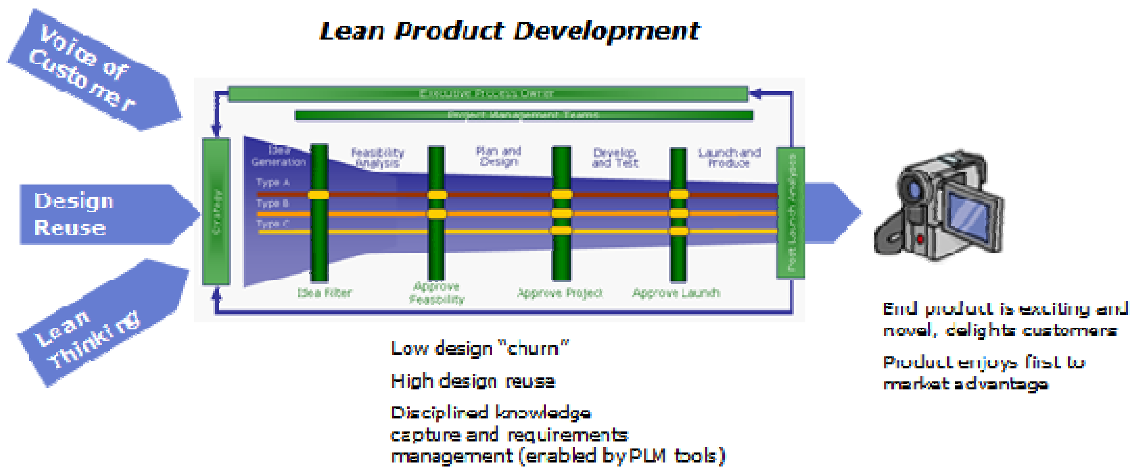


Lean Promotes Innovation; Decreases Time to Market

Reconfiguration in multiple dimensions using lean and Six Sigma techniques



New work configuration is modeled and expressed as new process



9 month : Concept to Launch

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Lean Product Development

Companies often have fundamentally sound product development processes, yet operational problems regularly compromise product launches

Observed product development problems

- Late engineering changes
- Untimely development decisions
- Design trades and testing out of phase with development schedule
- Supplier development schedule and quality problems
- Delayed product launches
- Extensive finished goods rework
- Unanticipated component failures
- Frequent recalls; often several on same model
- Unacceptable warranty costs
- Customer safety concerns
- Number of configurations

Cited Root Causes

- Inadequate forecasting of targets
- Lack of early consensus on program strategy and alignment of objectives
- Overly optimistic roadmaps
- Frequent, uncoordinated product changes from product development executives
- Poor process discipline
- Cultural bias against raising issues and making timing adjustments

Symptoms of Inefficient Engineering Processes

- Late to market launches
- Higher than expected product costs
- Higher than expected development cost

A lack of discipline to comply with standard product development processes is often the leading cause of product development related business failures

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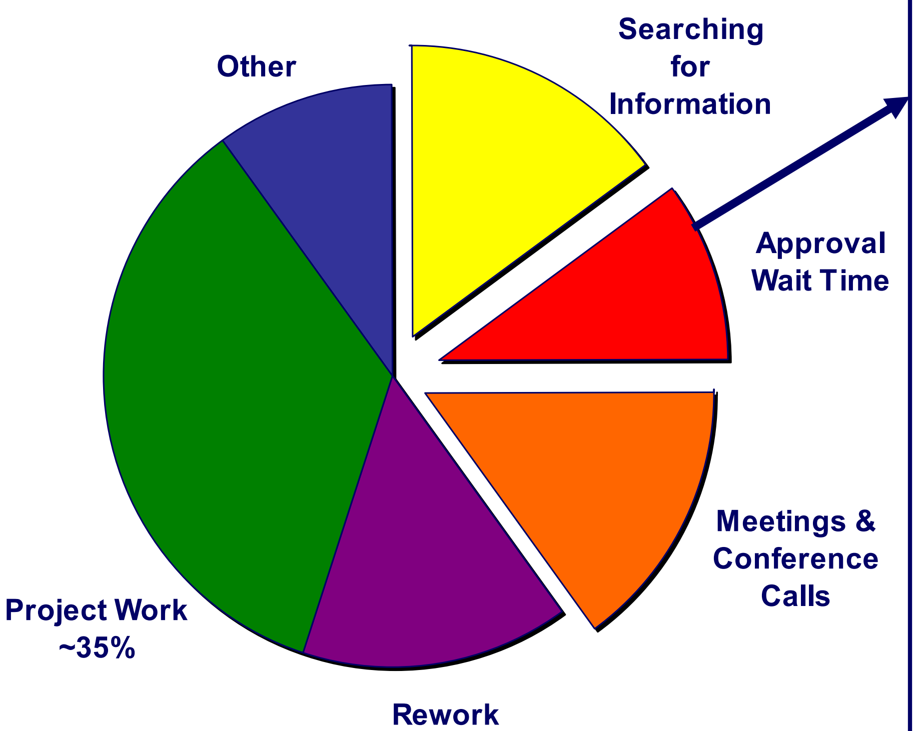
Lean Approach #1 – Eliminate Non-Productive Time



"Employees believe only two days per week is value-added time on projects"

<u>Source</u>*: Various DC client projects*

In our experience, 50% to 60% of development time on a project can be non-productive:

- Inadequate access to the correct data
- Too many versions of the save data and no master record or owner
- Poor communication of information within the development process
- Engineers waiting for approval to start work on the next series of activities
- Endless unstructured standing meetings where no decisions are made and/or work progress made

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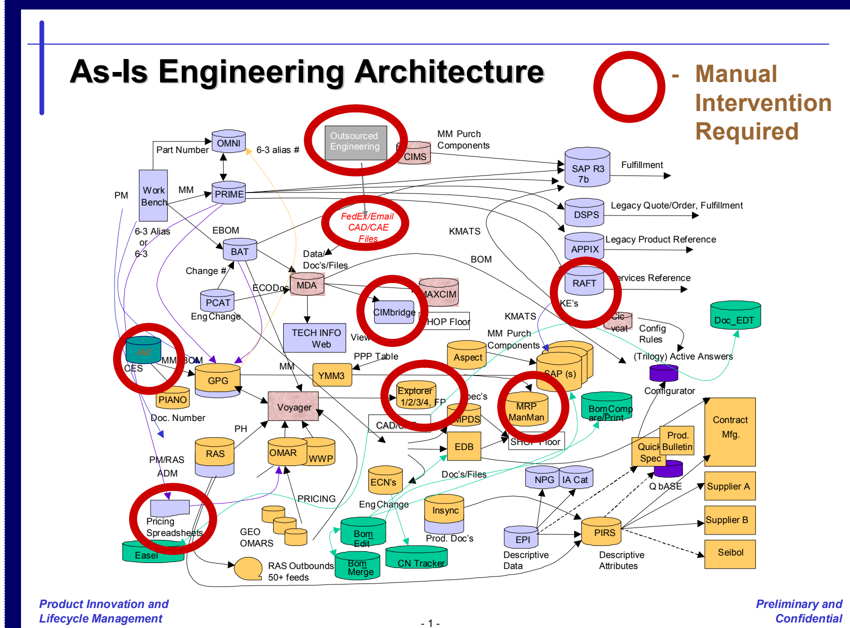
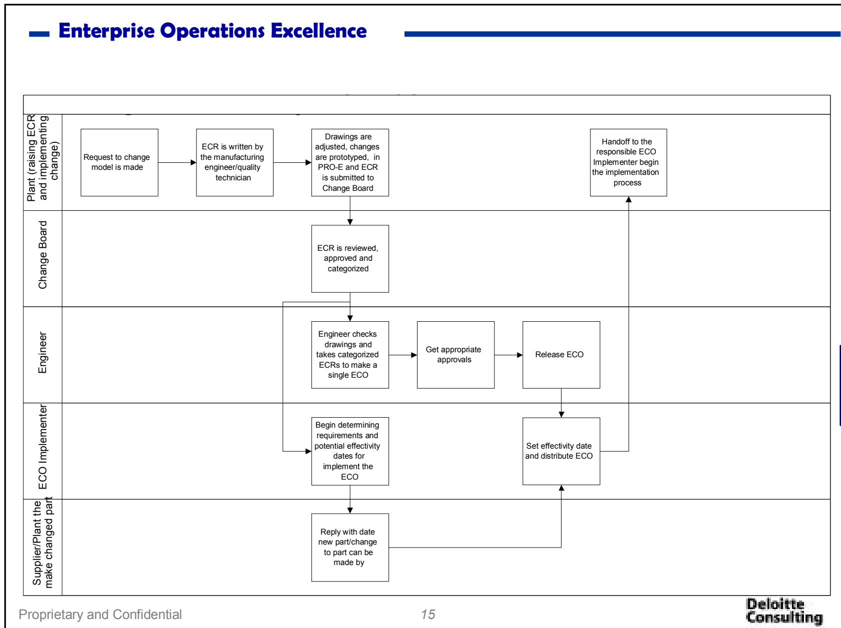
Lean Approach #2 – Rationalize the Systems

Example Fortune 500 Engineering Application Architecture



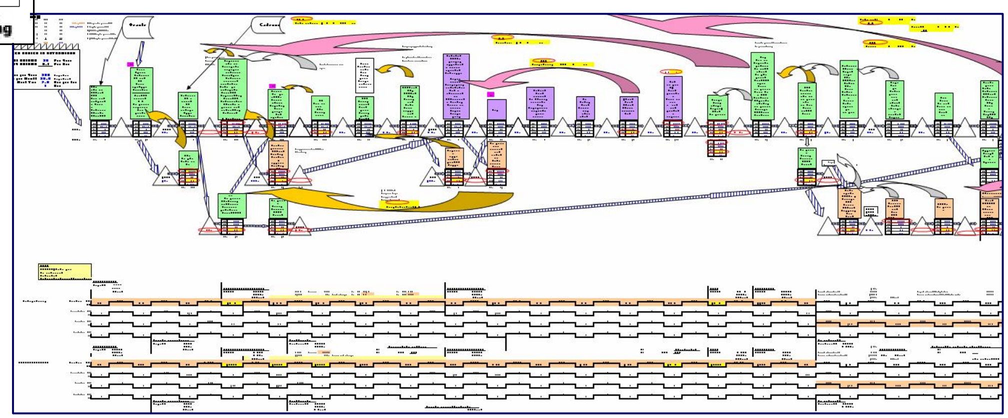
- There are multiple systems performing the same functions
- There are multiple sources of master data
- Engineers are recreating designs because they cannot find previous/similar designs
- Due to the above issues, many companies have experienced…
  - Limited design reuse
  - Poor quality from bad designs
  - Scrap due to lack of coordination around engineering changes
  - Ordering wrong materials
  - High number of warranty claims due to poor component and sub-system integration

Lean Approach # 3 – Lean out the Process



Typical approach is to:

1. Map out the process flow via a process flow diagram
2. Conduct value stream analysis to identify and eliminate wait time, approval time, and other non-value added activities



- **Traditional process mapping masks the actual behavior of the process**
- **Even traditional value stream mapping doesn't uncover the true process behavior**

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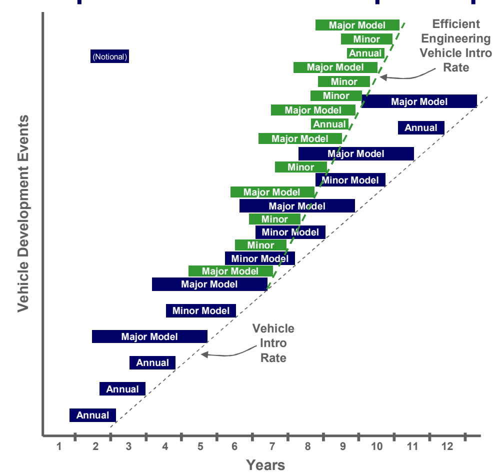
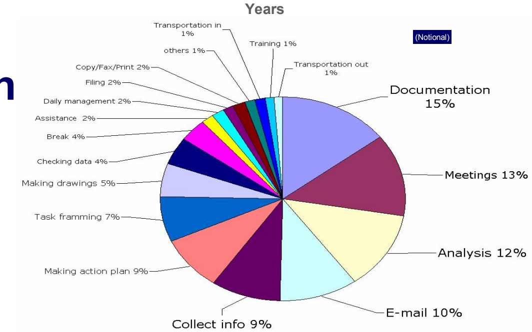
Product development efficiency is strategic and valuable – it enhances overall competitiveness as well as product economics

- **Product development efficiency fundamentals**
  - Improved product development efficiency can shorten vehicle development cycle time and reduce development costs…
  - … which enables increases in the vehicle development rate and reduces the unit volumes necessary for vehicle level profitability
  - … which further enables market share gains without additional engineering resources

Corporate vehicle development plan



- **Traditional measures of Lean Product Development do not provide sufficient insight, focusing mostly on**
  - Identification of activities performed by the engineers
  - Categorization of tasks into core and non-core activities
  - Breakdown of the time spent by engineering for various tasks



A paradigm shift is required for an accurate assessment of product design and development process efficiency

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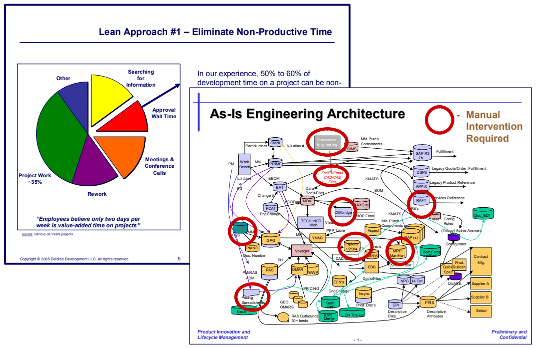
Product development inefficiency is typically caused by two broad categories of process failure

Total Improvement Opportunity

30-40%

Administrative burden

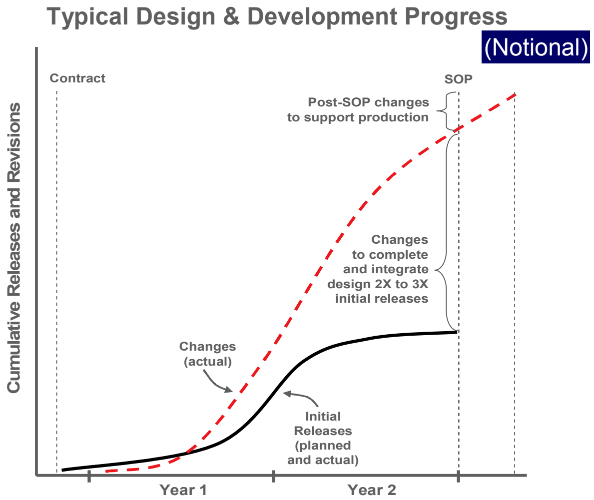
- Excessive administrative burden to due to awkward
  organizational arrangements, mis-aligned priorities and metrics, and communication difficulties.
- These are often referred to as "non-core" activities



60-70%

Rework and change

- Excessive rework and change caused by design and test process execution failures, including failure to ensure cross-functional integration in the design process.
- While rework and change often are considered "core" activity, they represents "slippage" in core processes which can be minimized



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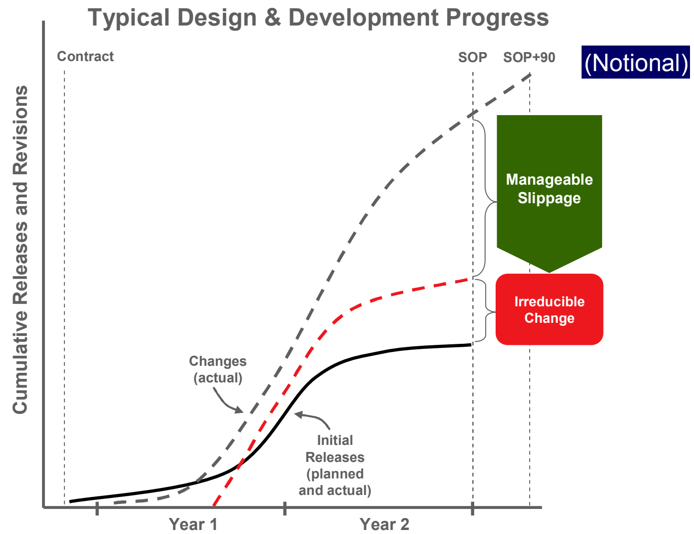
Slippage can be understood, measured, and reduced through practical improvements to planning, design processes, and the appropriate use of engineering tools

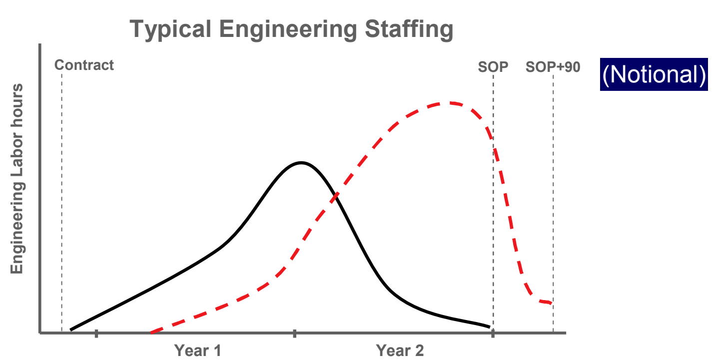
Managing slippage

- Typically, slippage in core product development processes is caused by limitations in:
  - Management and planning
  - Design processes and disciplines
  - Design tools and systems
- Chief among these causes are unexpected content growth and poorly coordinated or late design changes
- Slippage can often be managed via adjustments to existing processes and systems coupled with leadership recognition of it as a major competitive issue

Product development resources

- Design resource consumption patterns can also reveal slippage (and quality risks) as designs are reworked to completion





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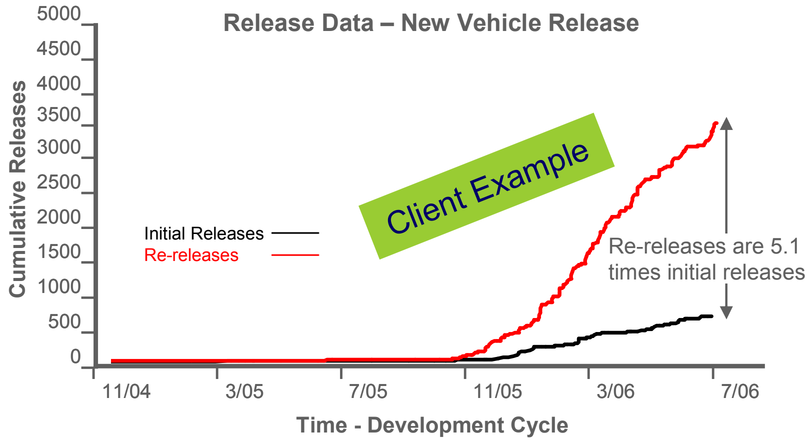
Our experience in measuring product development efficiency indicates that release and design resource level data conforms to the typical patterns

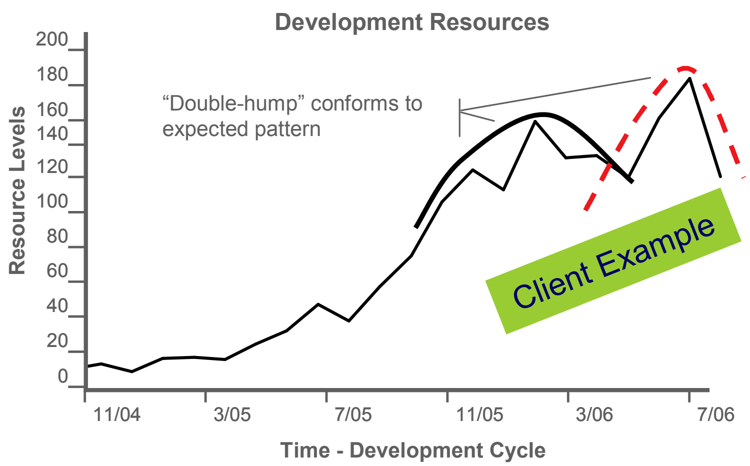
Managing slippage

- The number of initial releases is consistently dwarfed by subsequent changes and re-releases



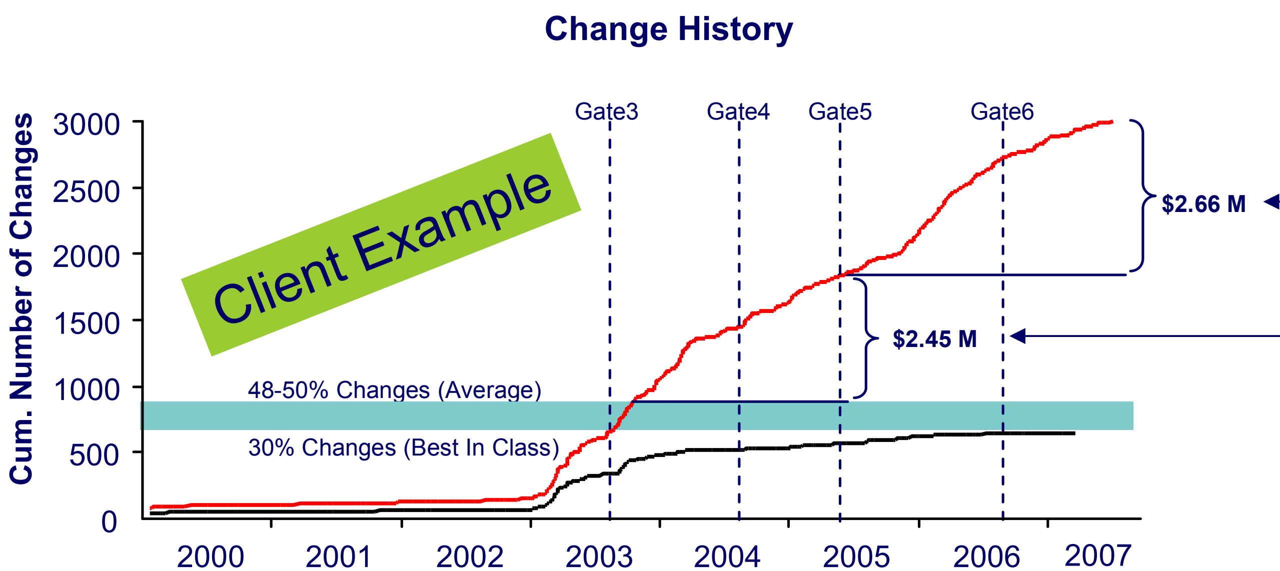
Product development resources

- Engineering resource level records often indicate that the majority of engineering effort is affiliated with re-work and change of initial releases and also often reappears as a concentration of effort just prior to start of production



Data Analysis – Change History Analysis

The value per program of eliminating rework and change can be staggering



Actual hours beyond Gate 5	70,047
Hours spent on changes	28,019
Transfer rate $/Hr	$95/Hour
Potential opportunity by reducing churn beyond Gate 5	$2.66 M
Additional opportunity by reducing churn to acceptable threshold limits	$2.45 M
Estimated total potential benefits	**$5.11 M**

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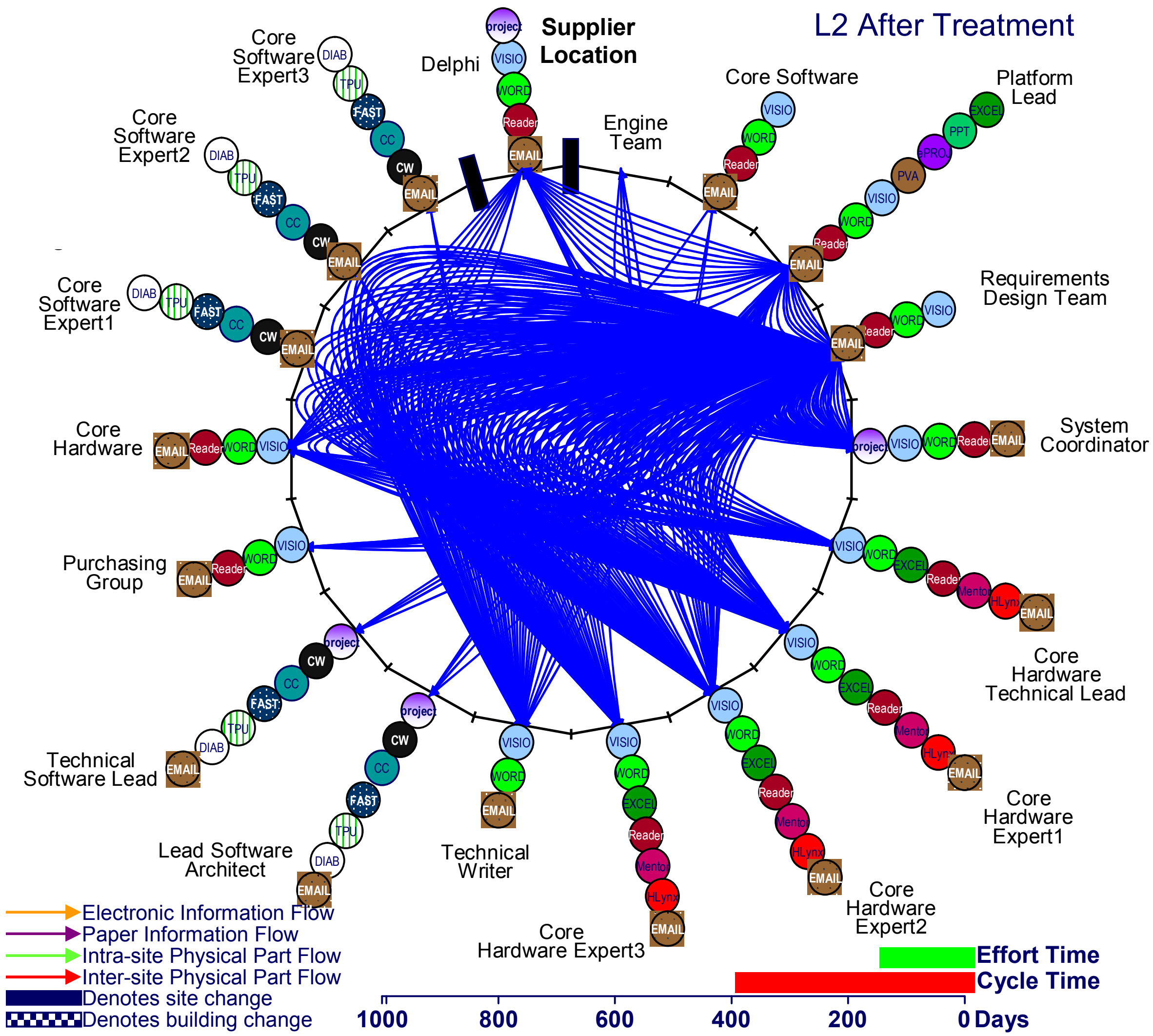
Value Stream Analysis: Sample - Requirements Development

Value Stream Analysis is also useful when applied to identify the complexity and inefficiencies of processes. In this example we revealed the complexities experienced in a requirements management process



Scope

- Receive requirements from Core Engines; Create "build to spec" documentation and work with supplier to deliver hardware.

Findings

- Flexibility is built into the hardware design to accommodate uncertain design changes. Once in production, flexibility is removed through cost-cutting exercises requiring added engineering time
- Initial requirements were provided 6 months behind schedule, leaving approximately 95% of all activities to be performed after the planned requirements freeze date
- Time constraints prevent late changes from being incorporated into component design; forcing alternate design changes to other components or in core engine designs
- Core Engineers were unable to provide detailed requirements upfront because immediate needs and issues demanded attention – "firefighting mentality"

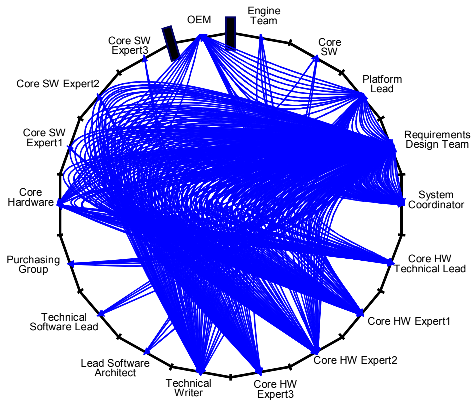
Statistics

Total Systems Employed:	16
Total Information Hand-offs:	379
Effort Time:	165 days
Cycle Time:	414 days

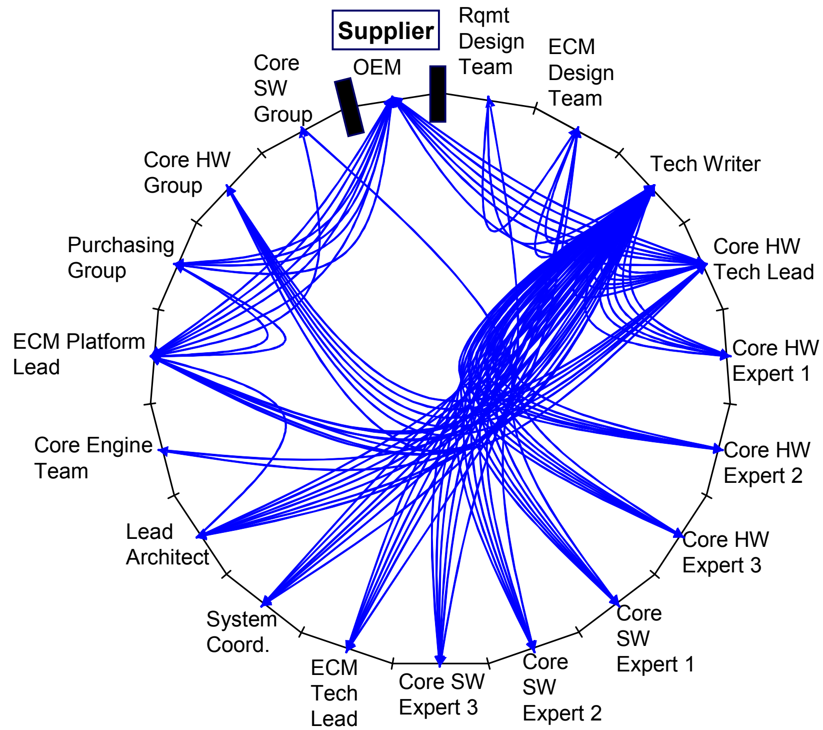
Impact to Process Complexity – After Treatment Example

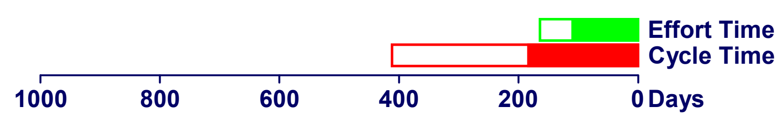
Reductions to operational complexity and cost are easily visualized and quantified

As-Is Requirements Mgt. Process



To-Be Engineering Change Request Process





Reconfiguration Impacts:

- Organizational hand-offs reduced by 80% 379 to 79
- Cycle time reduction of approximately 55% from 414 days to 185 days
- Total effort time is reduced by 32% from 165 days to 112 days

Reconfiguration Design Involved:

- Workflow changes
- Policy changes
- Organizational alignment
- Physical work location

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Lean Product Development Assessment

We utilized a capability maturity model to convey and assess the lean attributes present in new product introduction processes and the gaps that must be addressed to improve Lean performance

Lean Fundamentals	Lean Product Roadmaps	Pull Based Customer Features / Requirements	Integrated and Synchronized Scheduling	Co-Located Cross Functional Cells	Error-Proofing “Templates to reduce errors”
Best-in-Class	▪ Product roadmaps sequenced for ***maximum re-use, strict deadlines, strategic priorities***, capacity planning needs	▪ ***Lead customers*** are regular team members who ***help define, prioritize, and freeze requirements***. Changes require ***business case justification***	▪ ***Integrated project plan*** to synchronize process flow and execution. Utilize ***regular critical path re-planning*** to prioritize capacity	▪ Collocation of team resources are ***arranged to improve the information flow and execution of work***	▪ ***Standardized templates and best-in-class examples*** are ***electronically available*** to reduce time spent on search, learning, definition and error correction
Intermediate	▪ Product roadmaps are defined as a ***planning mechanism*** to jump-start technical development and set basis ***for future program direction***	▪ Sales/Marketing conduct focused groups to gather / prioritize features and requirements. ***Engineering responsible for freezing requirements***	▪ ***Integrated project plans*** across all functions that is ***regularly updated*** but no critical path analysis or re-planning	▪ Cross functional teams (business, engineering and technical) are ***co-located***	▪ ***Some standardized templates*** defined for critical deliverables. Accessed ***via static intranet***. Limited capture and sharing of best practices
Basic	▪ Product roadmaps not linked to business strategy. No linkage between technology and product roadmaps	▪ Internal engineering defines features and requirements. ***Lack of clarity/priority drives “over” engineering of requirements***	▪ ***Many non-integrated functional project plans***. No single project manager driving the execution of the program	▪ Engineering functions ***reside in different locations*** but collaborate via cross functional team meetings	▪ Clear definition of roles but ***limited standard templates***. ***Tribal knowledge is typical***

Current State

Desired State

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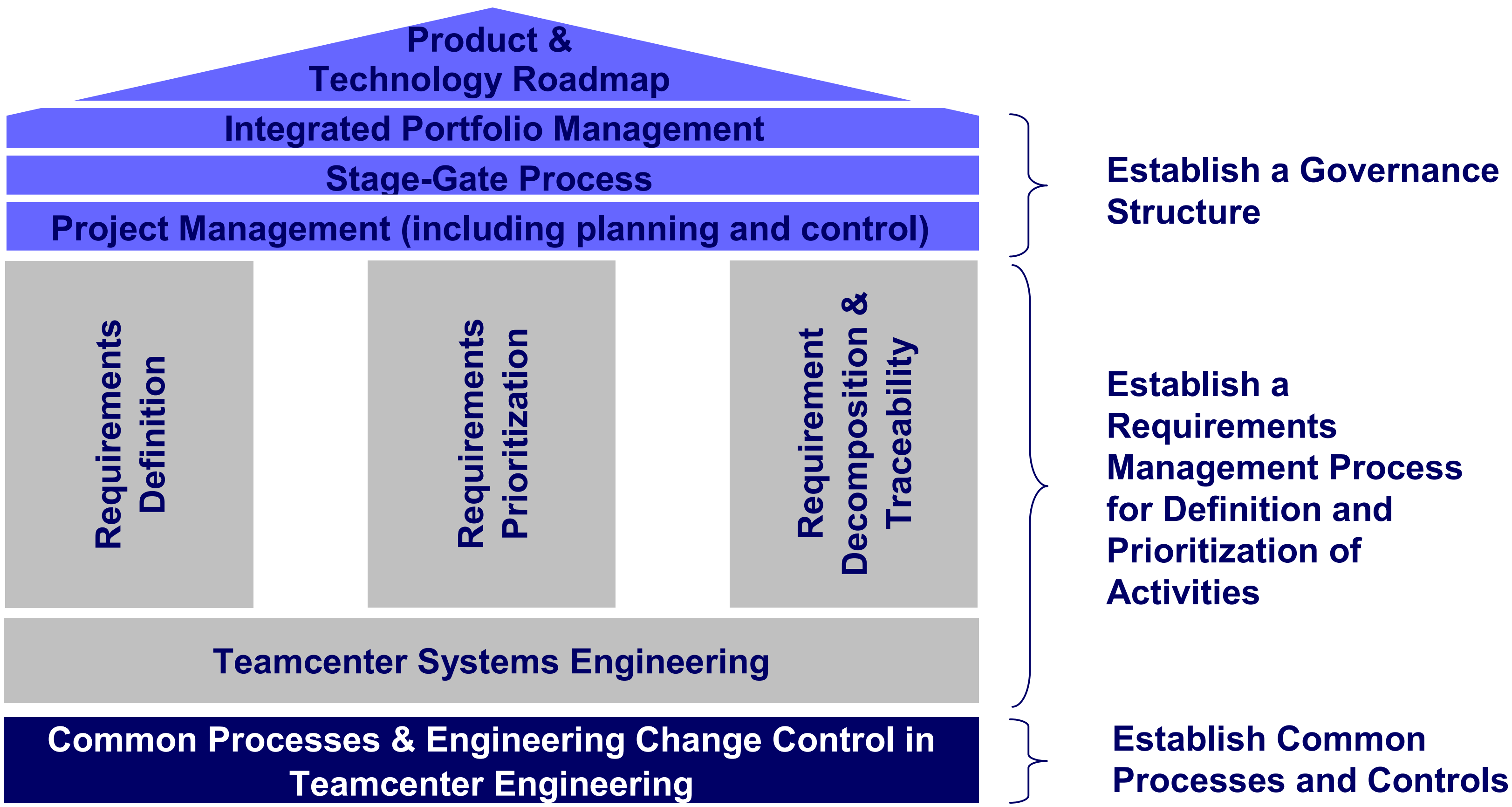
Lean Attributes Applied to Large Electronics Manufacturer

The framework illustrates that each element is part of an integrated solution that can be deployed in logical groupings.



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Selected Case Studies

Company	Objectives	Benefits
CASE STUDY 1 - **Global Automotive OEM**	Develop the metrics, processes and tools that provide visibility into engineering efficiency and identify root causes of engineering efficiency. The focus was on reduction of non-core activities which consumed engineering time and resulted in higher product development costs	– $2.5M or 298 man-months per full vehicle program from reduction in slippage – 3.5% or $500K reduction of manpower cost towards a new vehicle program through improved release and change management process
CASE STUDY 2 - **Construction Equipment Manufacturer**	Deployed lean business solutions for product design and development concurrent with enabling technology to reduce work complexity, improve information flow and management and increase process integration	– Reduction of 30,000 labor hours that could be redirected to value creating activities – Reduced effort time for engineering change notice through elimination of duplicate data entry and routing steps
CASE STUDY 3 - **Aerospace Company**	Designed work re-configuration at the process execution level of design and development. This optimized performance across the critical value stream activities of the design and development process	– Cycle time to approve a schedule change decreased from up to 60 days to less than 3 days – Number of people required to make a schedule change decision is reduced from at least 18 to 4-6 resources – Reduction in headcount by 106, translating to a reduction of $10.6 million in labor costs during the first year
CASE STUDY 4 - **Construction Equipment Manufacturer**	Developed solutions for reduction of non-value added activities with regard to requirement management and engineering change control that consume engineering time and increase cost and cycle time. Identified improvement opportunities related to process, policy, organizational alignment, and information flow	– Additional capacity gain of 144 FTE's or $27.7M annually across top tier programs – Improved visibility into issue identification, escalation, and resolution process – Reduction of non-value added time through implementation of standard processes, templates, common repositories and communication plans

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